

REMARKS

This responds to the Office Action mailed on April 6, 2007.

Claim 23 is amended and new claim 79 has been added. Accordingly, claims 23-25, 27-29 and 79 are under examination in this application.

Claim Objections

Claim 23 was objected to for minor informalities which have been addressed in this response.

§112 Rejection of the Claims

Claims 23 and 27 were rejected under 35 U.S.C. § 112, second paragraph, for indefiniteness on the basis that the Examiner did “not know which side of the layers are considered first side.” Applicants respectfully submit that Applicants are unquestionably entitled to be their own lexicographer, and that the use of terms such as “first” and “second” to characterize structural elements or portions of such elements and/or their relative placement or orientation is so manifestly common and well-known that such cannot be a valid basis for rejection. Applicants also submit that the relative positioning is very clear from the language of both claims 23 and 27. As set forth in claim 23, the respective first sides of the first and second metal contact layers are positioned “facing” each another, and thereby form a “channel” between the two metal contact layers. Applicants therefore request the reconsideration and withdrawal of this rejection.

The Rejections of the Claims under §103

Claims 23-25 and 27-28

Claims 23-25 and 27-28 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Brown (U.S. 6,118,204) in view of Snyder et al. (U.S. 6,700,298) and Kherani et al. (U.S. 5,606,213). The Office Action asserted that Brown discloses the Applicants’ claimed limitations with the exception of liquid semiconductor containing a solution of isotopes and spacers, which

were asserted to be taught by Snyder, and a Schottky contact, which was asserted to be taught by Kherani. Applicants respectfully submit that there is no reason one skilled in the art would combine these references in the manner asserted. The piecing together of isolated elements from each of the references while ignoring fundamental differences between the references, results in a combination that could only be obtained through an impermissible use of hindsight. Without the guidance of Applicants' specification and claims, this combination would never be made.

Applicants will first address the teachings of each of the references. The Brown and Kherani references were addressed at some length in the prior response. Pertinent portions of that discussion will be repeated here.

Brown and Kherani

Brown was the primary reference used in the rejections of the prior Office Action. Brown discloses a power cell for directly converting ionizing radiation into electrical energy.¹ That power source includes: (1) an electronegative material layered in a semiconductor to form a first region that has a high density of conduction electrons (the N-layers region); (2) an electropositive material also layered in the semiconductor to form a second region with a high density of holes (the P-layers region); and (3) a neutral zone of semiconductor material doped with radioactive isotope such as tritium separating the N-layers region and the P-layers region.² Current is generated in the disclosed cell by the difference in work functions between the electropositive region 3 in the semiconductor material and the electronegative region 2 in the semiconductor material.³

The teachings of Brown to one skilled in the art must be evaluated by understanding the type of device actually disclosed by Brown, and the constraints upon it. Although Brown does not directly characterize his device, it is apparent to one skilled in the art that Brown discloses a

¹ See Brown, col. 3, lines 52-55.

² See Brown col. 3, lines 52-65.

³ See Brown, col. 6, lines 46-61. The Examiner's attention is also directed to Applicants' prior response, wherein the significance of the outer semiconductor regions was discussed at some length, as was Brown's discussion of the electrodes contacting those regions. For example, the discussion of the prior art at pages 40-52 of the Amendment & Response Under 37 C.F.R. 1.116, submitted in response to the Office Action of July 14, 2006.

structure based upon the described p-i-n junction formed within the semiconductor region of the device. This type of device is formed by a neutral zone of semiconductor material (region 4, in Brown), which is contained between n-layers and p-layers of semiconductor material (regions 2 and 3 in Brown). This type of device operates on solid state physics principles, with defined semiconductor regions forming diodes, and thus a rectifier, in the multi-layer semiconductor region; in combination with ionization sources in the central semiconductor region. In this device, differences in work functions between the n- and p-regions in the semiconductor material cause the current flow between those solid semiconductor regions. This current flows through sequential transfer of charges through an ordered system, such as a crystalline lattice of the solid semiconductor regions. Such devices rely upon the relatively non-conductive lattice of the solid semiconductor, whereby the electrodes are relatively electrically isolated from one another, such that the charges transfer through the semiconductor from one electrode to the other.

This operation of Brown is similar to that of the applied Kherani patent. Kherani describes "nuclear batteries" which are expressly described as formed of a p-i-n junction (as well as an embodiment in the form of a p-n junction). The p-i-n junction embodiment of Kherani is similar in basic structure and operation to that described in Brown.⁴ Kherani again discloses a solid state semiconductor device having three distinct semiconductor regions: a p-type tritiated amorphous carbon region 21, a n-type tritiated amorphous silicon region 22, and an intrinsic tritiated amorphous silicon region 25 between the two. Kherani also states "the semiconductor junction may be either the p-n or the p-i-n type with an intrinsic or near intrinsic region disposed between the p and n (regions)."⁵ Kherani's specific contribution to the art was the use of a material such as amorphous silicon because it could form p-i-n junctions with a minimum of recombination centers. This reduction of density of recombination centers was perceived to be useful to increasing the excess carrier lifetime and the nuclear cell current.⁶ Kherani, like Brown, again relies on a sequential transfer of charges through the solid semiconductor to cause current flow from one semiconductor region to the other.

⁴ See Kherani, Figure 4 and discussion relating thereto.

⁵ See Kherani, col. 2, lines 38-40.

⁶ See Kherani, col. 3, lines 55-65.

Snyder

Snyder discloses a structure very different from those of Brown and Kherani. Snyder discloses an "alpha-voltaic power source" intended to generate a voltage through ionization of liquid gallium.⁷ Snyder discloses a holding container 110, having a volume of (preferably) liquid gallium 102 therein, with an anode 104 and a cathode 106 on opposing sides of container 110.⁸ Snyder states that a voltage will be present between the anode and cathode leads, depending on the differences in work function between the anode and cathode. Snyder discloses that in order to "activate the liquid gallium in order to provide sources of charge and sources of charge absorption," alpha particles emitted by a solid material, such as from a source 120 of Curium-244 will be used.⁹

Many aspects of the system proposed by Snyder are not at all clear. For example, Snyder relies upon the collision of alpha particles with gallium atoms to generate charge.¹⁰ Yet, as is known to those skilled in the art, alpha particles have a relatively large mass, which results in a relatively slow speed, such that they may be absorbed easily, for example by a sheet of paper. So the penetration of alpha particles from the source 120 of Snyder into a significant portion of the volume of liquid gallium or other material would be limited, apparently to less than 5-10 microns, where the liquid is gallium. So most of the gallium atoms will not be exposed to the alpha excitation. Thus, the generation of current at the levels described by Snyder as a result of such limited penetration of alpha particles seems, at best, unlikely.

Additionally, Snyder is less than clear about his proposal for an alternative embodiment wherein beta or gamma rays would be used as ionization sources, rather than alpha particles. In the primary embodiment, Snyder clearly prefers the use of liquid gallium in the device, even reciting that material in the title of the application. Snyder correctly characterizes gallium as being a semimetal, and addresses possible alternative materials to be used as substitutes for liquid gallium by stating that "semimetals are good candidates for such alternative materials."¹¹

⁷ See Snyder, title, and col. 1, lines 16-19.

⁸ See Snyder, Fig. 1 and col. 3, lines 23-36

⁹ See Snyder, col. 3, lines 58-64.

¹⁰ See Snyder, col. 2, lines 16-28.

¹¹ See Snyder, col. 3, lines 45-46.

However, when Snyder provides a cursory identification of alternative embodiments in which the radiation employed would be beta or gamma rays, Snyder states that “[t]he target liquid 102 generally has to be a liquid semiconductor or a semimetal with properties generally closer to a semiconductor.”¹² But Snyder does not indicate why that difference in the liquid component would be useful, or even viable. Snyder further does not state what other changes might need to be made for such a device to function. Accordingly, as to any embodiment using a liquid semiconductor, Snyder presents only an invitation for others to experiment.

One thing that is clear, however, to those skilled in the art is that the device of Snyder functions on a totally different principle than the devices of Brown or Kherani. As disclosed by the Snyder inventors, the Snyder cell is an electrolytic cell, wherein the liquid gallium is the electrolyte.¹³ However, in the Snyder cell, the ions and free electrons are created through alpha particle energy, rather than by electrochemical means. In Snyder's cell, the ions and electrons liberated through ionization move through a disordered system of the liquid gallium electrolyte, directly to one of the two electrodes. This is in stark contrast to the solid state semiconductor device of Brown and Kherani, as discussed above.

The Combination of Brown, Kherani and Snyder

The Office Action asserts that “Brown discloses applicant’s claim limitation except for liquid semiconductor contains a solution of radioisotopes and spacers which are taught by Snyder et al (Fig 1) and Schottky contact which is taught by Kherani et al. (Col. 6, lines 57-65).”¹⁴ The Office Action further asserts that it “would have been obvious to one of ordinary skill in the art to modify the nuclear voltaic cell as disclosed by Brown with the teachings of Snyder and Kherani”¹⁵ to use liquid semiconductor instead of solid semiconductor for the benefits of increased density (i.e., increased efficiency), diffusibility and conductivity, etc., as such a

¹² See Snyder, col. 3, lines 59-64.

¹³ See submitted reference entitled “Technical Support Package—Alpha-Voltaic Sources Using Liquid Ga as Conversion Medium”, authored by the inventors of the Snyder patent, and further describing the cell described in the patent. This paper is attached hereto for the Examiner’s convenience.

¹⁴ Office Action of 4/6/2007, pp. 4-5.

¹⁵ This statement seems to indicate that Kherani discloses a liquid semiconductor, which it clearly does not. Thus, Applicants assume this to be an error in the Office Action.

modification is no more than the work of an expedient within the art.”¹⁶ Applicants submit, however, that these assertions are simply wrong.

A first, and fundamental, error arises from the characterization of substitution of use of a liquid semiconductor as any sort of obvious “expedient within the art.” As noted above, Brown specifically addresses the placement of different metallic foils in the outermost regions --of the three distinct regions in the solid semiconductor-- in order to adjust the work functions in these outer semiconductor regions to improve functioning of the device. Thus, Brown specifically teaches away from adopting a structure in which (1) a single semiconductor region is used, (2) wherein the semiconductor is incapable of maintaining distinct and contrasting regions, and/or (3) wherein such metallic foils could not be used to adjust the work function of those contrasting regions on each side of the relatively undoped region. Thus, on at least these three bases, Brown expressly teaches away from the use of a liquid semiconductor.

Clearly, for a semiconductor material to have three different regions each with a distinct composition and set of properties, that semiconductor material must not allow any significant transfer or migration of the dopants or other constituent materials between the regions—i.e., that semiconductor material must be a solid. Thus, use of a liquid semiconductor (asserted in the Office Action to be “the work of an expedient in the art”), would discard the essential structure and operating principles of both Brown and Kherani, resulting in a non-functional device. Thus, the proposed combination is not one which would be obvious to one skilled in the art. Moreover, the essential structural requirements of Brown and Kherani expressly teach away from use of a semiconductor that will be at least generally homogeneous, as a liquid semiconductor will be. Applicants therefore respectfully submit that there is simply no teaching to one skilled in the art to make the asserted combination, and that such combination can only be suggested through impermissible use of hindsight.

Another error lies in the assertion in the Office Action that liquid semiconductor containing a solution of radioisotopes and spacers is taught by Snyder.¹⁷ In fact, Snyder does not

¹⁶ Office Action of 4/6/2007, p. 6.

contain any disclosure of a liquid semiconductor containing a radioactive isotope in solution, as recited in claim 23. Applicants first note that Snyder contains only a single mention of use of a liquid semiconductor—that found in the single paragraph discussion of an alternative embodiment, wherein beta or gamma rays might be used in place of the alpha particles used in the primary embodiment and as described in the title of the patent.¹⁸ Only in that description does Snyder suggest the use of a liquid semiconductor. And Snyder provides no further details about how such a device would be constructed. But Snyder never discloses or suggests the use of any solution containing a radioactive isotope, either with the liquid semiconductor or with the preferred semimetal, liquid gallium. Thus, even if Snyder is combined with Brown and Kherani—which Applicants submit is inappropriate—the combination fails to teach the invention as recited in independent claim 23.

Applicants further submit that the rejections of other claims serve to emphasize the hindsight reconstruction that is represented by the combinations in the Office Action. For example, in regard to claim 27, the Office Action states: “[i]t is considered that the Krypton dispersed in the semiconductor material reads on the plurality of spacers because Krypton is nonconductive and takes up space (i.e., a spacer) and is between the first and second metal contact layers and the current claim language does not require anything further.” The only reference in the combination which discusses Krypton is Brown; and Brown discusses Krypton as an alternative to tritium for the radioactive isotope.¹⁹ Brown specifically discloses the use of Krypton or tritium as being the gaseous environment in which sputter deposition of the semiconductor layer (4) is performed, such that atoms of the gas get trapped in the deposited semiconductor.²⁰ Accordingly, such Krypton is merely the various radioactive atoms distributed in a gas, and then trapped within a sputter-deposited film in Brown. Yet according to the position stated in the Office Action, such would meet the much more specific limitations for the recited spacers of claim 27. Following the position of the Office Action, every element with mass is a spacer, because it “takes up space.” The hindsight employed is further emphasized by

¹⁷ The reference in the Office Action is unclear, and Applicants wish to point out that Applicants’ independent claim 23 does not recite a “spacer.”

¹⁸ See Snyder, col. 4, lines 53-67.

¹⁹ See Brown, col. 7, lines 22-34 and col. 8, lines 49-56.

²⁰ Id.

the fact that the solid sputtered semiconductor of Brown would be completely missing in the proposed combination of the rejection, replaced by a liquid semiconductor.

Another example is in the rejection of claim 28, wherein the Office Action asserts that Brown in some way reads on claim 28. In that rejection, the Office Action states that Brown is now modified to include liquid semiconductor, although there is no apparent way for even that modification to be made. Nevertheless, the Office Action states that “it is inherent that any liquid will “flow” to fill its container, so Brown (assertedly) “reads on the claim language” of claim 28. So just as any element with mass is a “spacer” in the view of the Office Action, apparently, any liquid, no matter how contained, will “flow.” Applicants respectfully submit that these positions simply are not proper and rely upon interpretations and combinations that could only be reached using Applicants’ claims as a template in an impermissible use of hindsight.

Accordingly, for all the reasons set forth above, Applicants submit that the combination of references is simply not one which would be made by persons skilled in the art, but is made only through an attempt to reconstruct Applicants’ claims through an impermissible use of hindsight. But even if such a combination is made, it still fails to meet the limitations of Applicants’ claims 23-25 and 27-29. Applicants therefore respectfully request the reconsideration and withdrawal of the rejections, and the passing of these claims to issue.

Claim 29

Claim 29 was rejected under 35 USC § 103(a) as being unpatentable over Brown in view of any of Snyder et al. (6,700,298) and Kherani et al. and further in view of Knight (3,344,289). Claim 29 depends from independent claim 23. Applicants believe that claim 23 has been shown to be patentable over the applied references; and submit that claim 29 is similarly allowable at least for the reasons submitted with respect to claim 23.

CONCLUSION

Applicants respectfully submit that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney at (512) 628-9324 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

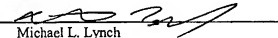
Respectfully submitted,

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